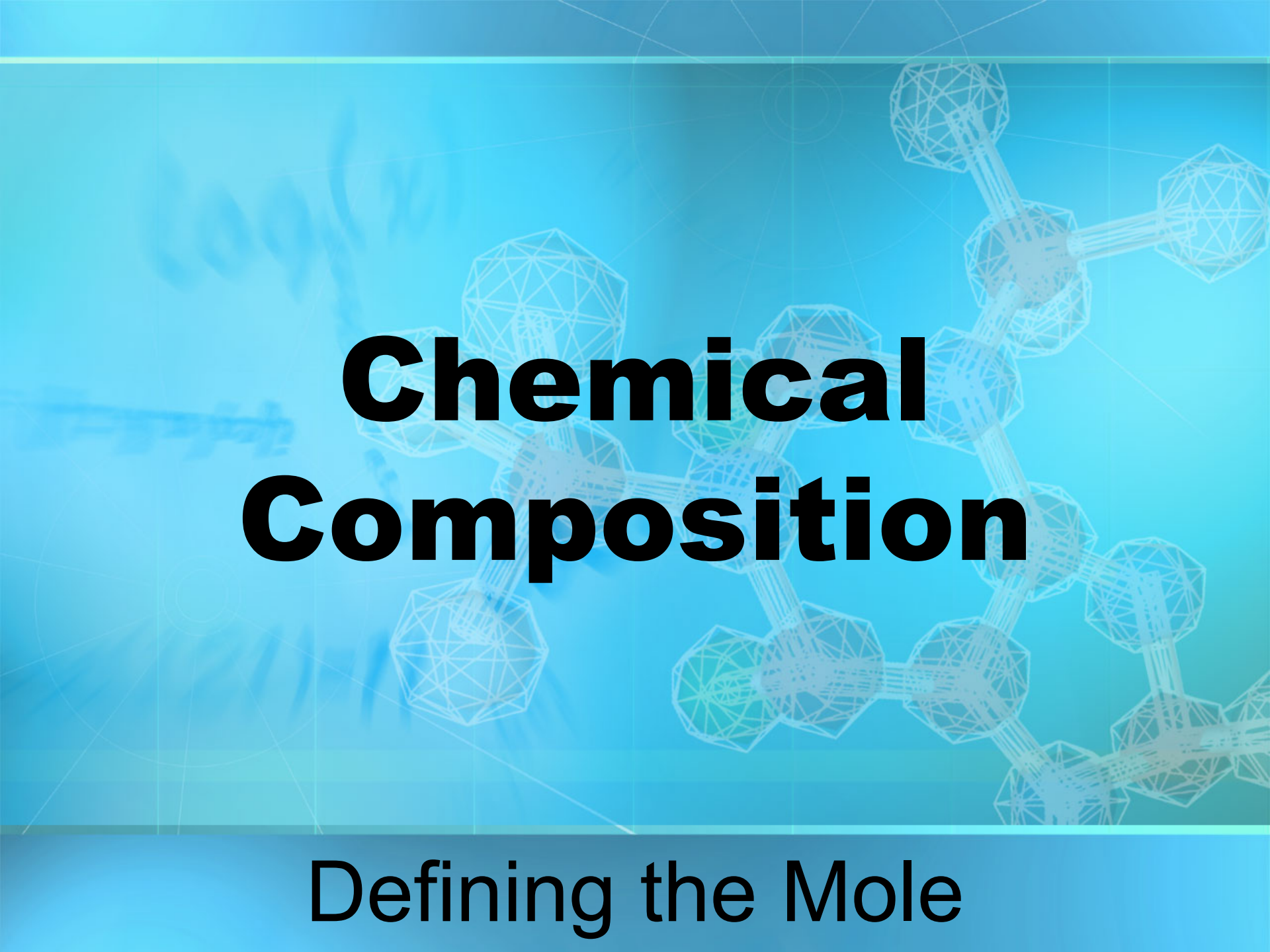

Chemical Composition

Defining the Mole

Imagine…

- Imagine if you had a recipe that looked like this:

Chocolate Chip Cookies:

Ingredients:

200 mini chocolate chips

1,000,000 grains of sugar

2,500,000 grains of flour

50,000 molecules of butter

2 eggs

What?

You could probably count 200 chocolate chips but how would you count a million grains of sugar or 2.5 million grains of flour or 50, 000 molecules of butter?

So just like we have units for baking:
1 cup chips
¾ cup sugar
2 cups flour

In chemistry, we use the Mole to measure small substances. Otherwise, it would be really hard to count individual atoms when we needed them for chemical reactions.

Defining the Mole

- It is important to realize that a mole describes the number of objects present. This is just like how we use the word "dozen" to mean 12.

	Silver (Ag)	Lead (Pb)
		
Average atomic mass of this element	107.9 amu	207.2 amu
Mass of this sample	107.9 g	207.2 g

Defining the Mole

Defining the Mole

- A sample of 107.9g of silver (Ag = 107.9 g atomic mass found on periodic table) contains the same number of atoms as 207.2g of lead (Pb = 207.2 amu).
- Both contain 6.02 x 10^{23} atoms.

	Silver (Ag)	Lead (Pb)
		
Average atomic mass of this element	107.9 amu	207.2 amu
Mass of this sample	107.9 g	207.2 g
Number of atoms in this sample	6.022×10^{23} atoms	6.022×10^{23} atoms

Defining the Mole

- If we weigh out samples of all the elements so that each sample has a mass that is equal to that element's atomic mass in grams, the samples all contain the same number of atoms.

- The mole is the unit all chemists use in describing numbers of atoms.

Defining the Mole

- **mole** (abbreviated **mol**)→ the number equal to the number of carbon atoms in 12.01 grams of pure carbon (^{12}C).
- Very precise techniques have been used to determine this number to be 6.022×10^{23}.
  - Also is called **Avogadro's number**.
  - One mole of something consists of 6.02×10^{23} units of that substance.

$6.02 \times 10^{23} =$
602,000,000,000,000,000,000,000

Defining the Mole

Using the Mole

- A sample of an element with a mass equal to that element's average atomic mass expressed in grams contains 1 mol of atoms.

Comparison of 1-Mol Samples of Various Elements

Element	Number of Atoms Present	Mass of Sample (g)
Copper	6.02×10^{23} atoms Cu	63.55 g Cu
Aluminum	6.02×10^{23} atoms Al	26.98 g Al
Iron	6.02×10^{23} atoms Fe	55.85 g Fe
Mercury	6.02×10^{23} atoms Hg	200.6 g Hg
Sulfur	6.02×10^{23} atoms S	32.07 g S
Iodine	6.02×10^{23} atoms I	126.9 g I

The Mole

A Closer Look

- To do chemical calculations, you must
  - understand what the mole means
  - determine the number of moles in a given mass of a substance
- We know that 1 mol is 6.02×10^{23} units, once we know the moles of atoms present, we can easily determine the number of atoms present.

Defining the Mole

- We carry out calculations using the equivalence statement **1 mol = 6.02 x 10^{23}** to determine the conversion factor.
- When you finish a problem, always think about the "reasonableness" of your answer.
  - Always include units as you do calculations and make sure they are correct at the end.
    - This general check can help you find errors such as inverted conversion factor or a number that was incorrectly entered into your calculator.

The End